

High Efficiency Hybrid Energy Storage Utilizing High Power Density Ultracapacitors For Long Duration Balloon Flights, Phase I

Completed Technology Project (2016 - 2016)



Project Introduction

FastCAP proposes to develop an ultra-high power density and high frequency ultracapacitor capable of surviving over the wide temperature range of -60C to 130C and exhibiting peak gravimetric and volumetric power density of 120kW/kg and 150kW/L respectively. FastCAP is planning to design and prototype a hybrid system comprised of the proposed ultracapacitor in parallel with a high energy density, rechargeable, lithium ion battery showing at least 50% volume reduction and 100% lifetime increase compared to stand-alone lithium batteries, meeting long duration research balloon requirements. During Phase I, FastCAP will evaluate both novel under-development and off-the-shelf lithium chemistries utilized in aerospace applications. The resulting hybrid battery-ultracapacitor (HBU) system combines the benefits of both technologies and will meet NASA's scientific balloon requirements of energy density, power density, shelf life, temperature, reliability and cycle life. This ultracapacitor can also be coupled to a piezoelectric generator, thanks to a high cut off frequency greater than 500Hz. The proposed HBU system will enable significant improvements in the design of power storage for terrestrial and planetary balloons, reducing their weight, volume, and complexity, while improving performance and relaxing design constraints on scarce candidate battery technologies. Compared to today's high-rate reserve and rechargeable battery technologies, the proposed hybrid system will provide much higher power and higher energy density, show tremendous improvement in cycle lifetime, and show reduced risk of explosion and thermal runaway associated with high-rate discharge, thanks to the power buffering role of the ultracapacitor within the HBU system. In applications where batteries are currently oversized for power handling, dramatic reductions in total energy storage system weight will be achieved by complementing those batteries with ultracapacitors.



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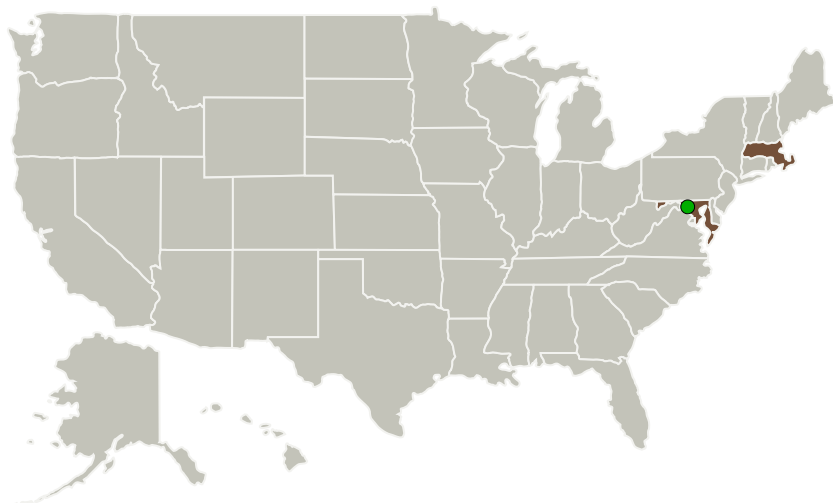
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Primary U.S. Work Locations and Key Partners



Organizations Performing Work	Role	Type	Location
FastCAP Systems Corporation	Lead Organization	Industry	Boston, Massachusetts
● Goddard Space Flight Center(GSFC)	Supporting Organization	NASA Center	Greenbelt, Maryland

Primary U.S. Work Locations

Maryland	Massachusetts
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Project Transitions

**June 2016:** Project Start**December 2016:** Closed out

Closeout Documentation:

- Final Summary Chart(<https://techport.nasa.gov/file/139673>)

Organizational Responsibility

Responsible Mission Directorate:

Space Technology Mission Directorate (STMD)

Lead Organization:

FastCAP Systems Corporation

Responsible Program:

Small Business Innovation Research/Small Business Tech Transfer

Project Management

Program Director:

Jason L Kessler

Program Manager:

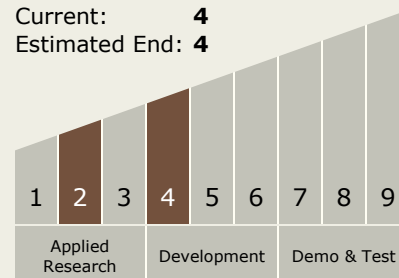
Carlos Torrez

Principal Investigator:

Fabrizio Martini

Technology Maturity (TRL)

Start: 2
Current: 4
Estimated End: 4



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Images



Briefing Chart Image

High Efficiency Hybrid Energy Storage Utilizing High Power Density Ultracapacitors For Long Duration Balloon Flights, Phase I
(<https://techport.nasa.gov/image/127766>)



Final Summary Chart Image

High Efficiency Hybrid Energy Storage Utilizing High Power Density Ultracapacitors For Long Duration Balloon Flights, Phase I
Project Image
(<https://techport.nasa.gov/image/132247>)

Technology Areas

Primary:

- TX03 Aerospace Power and Energy Storage
 - └ TX03.1 Power Generation and Energy Conversion
 - └ TX03.1.4 Dynamic Energy Conversion

Target Destinations

The Sun, Earth, The Moon, Mars, Others Inside the Solar System, Outside the Solar System